FOOD PROCESSING SURFACE CLEANING SYSTEM AND METHOD

The present invention relates to a system for cleaning food processing surfaces, particularly (but not necessarily) conveyor belts, more particularly (but not necessarily) for the sterilisation and/or removal of visible contamination (e.g. dust, hair, faeces, skin, meat pieces, blood, fat and protein) and non-visible contamination (e.g. bacteria, especially *E. coli*) from conveyor belts during the processing of animal carcasses and other raw meat products in abattoirs and other meat processing plants. However, the invention may be applied to the cleaning of conveyor belts and food processing surfaces throughout the food industry. The invention also relates to a corresponding method and use.

The cleaning of food processing surfaces, such as conveyor belts, is problematic. The use of water to clean areas in which food (especially raw meat) is processed can, if the water is not completely removed, allow bacteria to spread through films or rivulets of residual water and lead to cross-contamination. This is compounded by the difficulties in rapidly drying such surfaces. The use of hot air to dry residual water suffers the problem that any bacteria remaining on the surface are then encouraged to multiply. Moreover, the slats of conveyor belts typically have recesses and overlapping portions, which are hard to dry thoroughly.

Natural drying is slow, and leads to unacceptable down times during food processing if surfaces are cleaned with water during working hours.

Sterilisation using hot air has also been tried with conveyor belts, but again, unless complete sterilisation is achieved (again difficult with recesses and overlaps), the heat merely exacerbates the problem, encouraging bacterial replication.

Although EU regulations require that surfaces (e.g. conveyor belts) which come into contact with raw meat be sterilised at least every 4 hours, the practical difficulties involved lead to widespread non-compliance. Rather, many surfaces such as conveyor belts are sterilised only overnight, to allow complete sterilisation and complete air drying of the surfaces, without requiring the plant to be shut down during normal operating hours.

An object of the invention is to address these and other problems of cleaning food processing surfaces.

The inventor has now surprisingly found that the use of a hot water and vacuum system, as described below, can allow good cleaning of conveyor belts and other food processing surfaces, with good removal of residual water.

Although sterilisation of the food processing surfaces is desirable, it is not an essential feature of the invention. For example, the invention may be used for intermediate cleaning, between complete sterilisations. Similarly, complete removal of the cleaning water, though desirable, is not an essential feature of the invention. Indeed, for some applications, 80% removal of the cleaning water may be adequate. Where raw meat is involved, however, at least about 95% removal of the

cleaning water is preferred, more preferably at least about 98%.

Accordingly, in a first aspect, the present invention provides a food processing surface cleaning system comprising:

a vacuum source;

a cleaning head, having walls defining a vacuum chamber in communication via a vacuum line with the vacuum source, the vacuum chamber having an open vacuum mouth; and

means for supplying a pressurised cleaning fluid via a fluid line to one or more cleaning fluid outlets within the vacuum chamber, the cleaning fluid outlets being directed to spray cleaning fluid towards the vacuum mouth;

whereby the vacuum mouth may in use be positioned near or against a food processing surface to allow sprayed cleaning fluid to contact the surface and be removed under vacuum via the vacuum line.

Generally, it is preferred to have a slight separation between the cleaning head and the surface being cleaned, both to avoid the formation of a vacuum lock (which may hinder the removal of cleaning fluid) and to prevent the spreading of contamination by the cleaning head itself.

Preferably the cleaning fluid outlet(s) is/are configured to spray cleaning fluid towards substantially the entire extent of the vacuum mouth, preferably so that the cleaning fluid washes the internal surfaces of the walls forming the vacuum chamber at the vacuum mouth. This can reduce contamination of the cleaning head itself (with

possible contamination of the food processing surface by the cleaning head).

The cleaning head may be fixed in position in the food processing area in which it is used. This is particularly suitable for conveyor belts, where the surface may move past the fixed cleaning head. Alternatively, it may be movable within a fixed range (e.g. to move relative to a static meat processing surface, such as a table or butcher's block), or may be fully movable, e.g. to allow cleaning of different meat processing surfaces (e.g. different surfaces, especially conveyor belts, within the same meat processing plant). For use in cleaning conveyors, it is preferably fixed in position during the cleaning operation.

"Food processing surface" is to be interpreted as meaning any surface on which food is commonly processed, especially industrially and/or commercially, especially in food processing plants, and may in particular include conveyor belts, tables, butchers' blocks and sandwich processing areas. In particular, the food processing surface may be a surface on which raw meat is processed, but the invention applies also to other foods, e.g. conveyors or other surfaces used in industrial frying, baking or other cooking or food processing operations.

The cleaning fluid is preferably generated by mixing hot water and steam. Usually no other components of cleaning fluid are required, though chemical cleaning agents may be added. Preferably the temperature of the cleaning fluid is sufficient to achieve temperature sterilisation of the food processing surface, i.e. 71.5°C or 72°C or

higher. More preferably the temperature of the water is higher than 71.5°C, such that the temperature of the cleaning fluid in contact with the food processing surface is at least about 71.5°C or 72°C. For example, the temperature of the cleaning fluid in the cleaning fluid supply line and/or when leaving the cleaning fluid outlets may be at least about 75°C, 80°C, 85°C, 90°C, 95°C or 98°C.

In use, the pressure under which the cleaning fluid is supplied to the cleaning fluid outlets will be matched with the vacuum pressure and airflow in the vacuum line, such that the cleaning fluid contacts the food processing surface with sufficient force and in sufficient quantity for the desired cleaning effect to occur, and such that it is substantially entirely removed from the food processing surface via the vacuum line. Suitable cleaning fluid pressures may be in the range of 15 to 50 psi, typically using flow rates of 5 to 50 gallons per hour, more preferably 5 to 28 gallons per hour. For certain applications (especially in systems having several cleaning fluid outlets), flow rates of up to 50 gallons per hour may be used, e.g. 28 to 50 gallons per hour. Suitable vacuum pressure may be about 5-12, preferably about 8.5 inches of mercury. Suitable air flow in the vacuum line may be about 200 cubic feet per minute.

Hot water and steam are typically available on-site in food processing plants, and the system may be fed from such supplies at plant pressure. Typically, this will be higher than the pressure required at the cleaning head, so the system preferably has reduction valves to reduce

the pressure of the hot water and/or steam supplies. However, other hot water and/or steam supplies, such as mobile units, are also contemplated (such as mobile steam generators typically capable of producing 18 kg steam per hour). The entire system may be mobile. Preferably, however, it is plumbed in to a commercial or industrial food processing site.

Preferably steam and/or hot water are mixed together to form the cleaning fluid. The system preferably has a control unit for controlling the mixing to achieve the desired cleaning fluid temperature and/or pressure. Such a control unit may be valve operated and may include pressure and/or temperature gauges, especially for the cleaning fluid downstream of mixing.

The system may allow simultaneous operation of a plurality of cleaning heads, having respective cleaning fluid, vacuum and (if applicable, see below) steam lines.

The vacuum source is typically an air turbine, and is preferably separated from the cleaning heads by a separator in the vacuum line, to remove the cleaning fluid and debris carried by the cleaning fluid from the airflow in the vacuum line. The separator may be supplemented by one or more filters.

The cleaning head preferably has a generally oblong vacuum mouth. The cleaning head preferably has an elongate vacuum mouth. The larger dimension of the vacuum mouth will henceforth be referred to as its width.

Preferably the cleaning fluid outlet(s) is/are one or

more fishtail nozzles.

For vacuum mouth widths of greater than about 5 inches (about 12.5 cm), it is desirable for the vacuum line to be branched, different branches being in communication with the vacuum chamber at different points along the width of the vacuum mouth. With wide vacuum mouths and unbranched vacuum lines, the vacuum pressure at the portion of the vacuum mouth far removed from the vacuum line will be significantly lower than at positions near the vacuum line, and may be insufficient to remove substantially all the cleaning fluid from the food processing surface. Where the vacuum line is branched, the branches preferably include valves (e.g. ball valves or butterfly valves, ball valves being preferred) to allow the vacuum pressure across the different branches to be equalised (or otherwise set as necessary to achieve both adequate cleaning of and adequate removal of cleaning fluid from the food processing surface).

The width of the vacuum mouth is preferably at least 5 inches (about 12.5 cm), more preferably at least about 8 inches (about 20 cm) and may be of any size up to about 800 mm (about 32 inches) or even more, e.g. up to about 36 inches (about 91.5 cm). Other preferred minimum widths are about 12 inches (about 30 cm); about 15 inches (about 38cm); about 18 inches (about 46 cm); and about 24 inches (about 61 cm). Generally, the width of the vacuum mouth will be approximately the same as the smaller dimension of the food processing surface intended to be cleaned. In particular, the width of the vacuum mouth may be approximately the same as the width of a conveyor belt intended to be cleaned. Alternatively, a narrower

cleaning head could be used. For example a static surface such a table or butcher's block could be cleaned by several passes of a narrower cleaning head; a moving surface, such as a conveyor belt could be cleaned by a plurality of overlapping narrower cleaning heads.

Preferably the cleaning head (especially an elongate cleaning head) has a plurality of cleaning fluid outlets, preferably fishtail nozzles, preferably arranged generally in a line, more preferably generally across substantially the entire width of the vacuum chamber.

The cleaning head may comprise at least 2, at least 3, at least 4, at least 5, at least 6, at least 7, at least 8, at least 9, or at least 10 nozzles. The cleaning head may have up to 20, up to 18, up to 16, up to 14, up to 12, up to 10, up to 8 or , up to 6 nozzles. Each individual combination of these minimum and maximum numbers is specifically contemplated.

Where the cleaning head comprises a plurality of cleaning fluid outlets, these are preferably supplied with cleaning fluid via a branched cleaning fluid supply line. Again, the branches of the cleaning fluid supply line are preferably fitted with valves to allow the cleaning fluid pressure at the different cleaning fluid outlets to be equalised (or otherwise set as necessary to achieve both adequate cleaning of and adequate removal of cleaning fluid from the food processing surface). Again, ball valves are preferred, though other types of valve are contemplated, such as butterfly valves.

The cleaning head may be advantageously positioned at a

bend in a conveyor belt, preferably where the slats of the conveyor are maximally separated.

The system may comprise means for supplying steam to a manifold on the outside of the cleaning head, the manifold having apertures through which steam may in use be directed towards vacuum mouth-defining portions of the walls of the cleaning head. This has been found to allow the temperature of the walls defining the vacuum chamber to reach sterilisation temperature at lower steam pressures than steam jets from nozzles or steam shrouds. Where this feature is present, the walls defining the vacuum mouth are preferably irregular, e.g. slotted, to allow the steam to be withdrawn under vacuum without significantly impinging on the food processing surface, to reduce the likelihood of condensate being left on the food processing surface.

Particularly for cleaning conveyor belts which have through-holes, the system may comprise an air blower. The mouth through which the air is blown is preferably of dimensions similar to those of the vacuum mouth. The vacuum mouth and air blowing mouth may then be aligned with the belt running therebetween, the air blower assisting in the removal of cleaning fluid from the conveyor belt, by blowing it from the belt towards the vacuum mouth.

Separate cleaning heads may be provided for respective surfaces of a conveyor belt. Such cleaning heads may be aligned, such that both surfaces are cleaned simultaneously, or may be offset.

In a second aspect, the invention further provides a method of cleaning a food processing surface, the method comprising:

providing a food processing surface cleaning system of the first aspect of the invention, with the vacuum mouth positioned near or against a food processing surface to be cleaned; and

adjusting the pressure under which the cleaning fluid is supplied, and the vacuum pressure and/or airflow in the vacuum line, such that sprayed cleaning fluid contacts the food processing surface and is substantially entirely removed via the vacuum line.

Preferred features of this aspect are as previously defined. In particular, the food processing surface is preferably a commercial and/or industrial food processing surface, more preferably a conveyor belt. Preferably at least 80% of the sprayed cleaning fluid is removed via the vacuum line, more preferably at least 95%, more preferably at least 98%.

In a third aspect, the invention provides the use of a food processing surface cleaning system of the first aspect to clean a food processing surface. Again, the food processing surface is preferably a commercial and/or industrial food processing surface, more preferably a conveyor belt.

Embodiments of the invention in its various aspects will now be described in detail, with reference to the accompanying drawings, in which:

Fig. 1 is a side view of a cleaning head of a food processing surface cleaning system according to the

invention;

Fig. 2 is a front elevation of a different, wider, cleaning head, positioned above a conveyor belt shown in cross section;

Fig. 3 is a front elevation of a still wider cleaning head, also positioned above a conveyor belt shown in cross section.

Shown in Fig. 1, a cleaning head 1 of a food processing surface cleaning system comprises walls 2, 4, 6 of stainless steel, which define a vacuum chamber 8, having a generally oblong open vacuum mouth 10, approximately 5 inches (i.e. approximately 13 cm) wide, at one end of the chamber. At its other end 12, the vacuum chamber is in communication with a vacuum line and vacuum source (not shown). Of course, other sizes of cleaning head may be used. For example, a hand-held cleaning head for cleaning a work surface, such as a butcher's block, may have a vacuum mouth approximately 2 to 3 inches (5 to 7.5 cm) wide.

A fishtail nozzle 26 is disposed inside the vacuum chamber, directed towards the vacuum mouth. The nozzle is connected to and fed via a cleaning fluid supply line (shown schematically as 28). The connection is made via a connector 30 and a valve (shown schematically as 32), which are mounted on the outside of a wall 2 of the vacuum chamber 8.

The cleaning fluid supply line carries a mixture of hot water and steam from a mixer (not shown) having separate steam and hot water inputs. The valve allows the cleaning fluid supply to the nozzle to be controlled,

independently of any mixer controls.

The valve is preferably a ball valve, although any suitable type of valve (e.g. a butterfly valve) may be used. A ball valve has the advantage of providing finer flow control when partially closed than certain other types of valve.

In use, the fishtail nozzle sprays the hot water / steam mixture towards the vacuum mouth, where it washes the internal surfaces of the walls of the vacuum chamber, thereby to clean and sterilise them. The sprayed water / steam mixture is drawn back under vacuum into the vacuum chamber (and via the vacuum line into a waste collector), causing the spray to form a plume which substantially fills, and protrudes beyond, the vacuum mouth. This is achieved by suitable shaping of the aperture in the fishtail nozzle, and suitable adjustment of water pressure, vacuum pressure and airflow.

The vacuum mouth is positioned near a food processing surface, e.g. conveyor belt 40, such that the plume of spray protruding beyond the vacuum mouth impinges on the surface with a scrubbing action, which is highly effective at loosening and sterilising visible and non-visible contamination, which is carried into the vacuum chamber and into the waste collector along with the water.

In this embodiment, the cleaning head is fixed in position relative to the conveyor belt. The vacuum mouth is prevented by the fixings from forming a vacuum lock against the conveyor belt. In other embodiments, this

may be achieved by providing a non-straight (e.g. slotted) edge to the vacuum mouth.

Controls (not shown) are provided in the system for adjusting pressure, temperature and airflow in the vacuum, steam and hot water lines.

Shown in Fig. 2 positioned over a conveyor belt 40 (shown in cross section) is a wider cleaning head 101. This cleaning head is generally similar to that shown in Fig. 1, the main difference being that the vacuum line 150 is branched, the two branches 152, 154 connecting with side walls 106 of the vacuum chamber 108. Valves (shown schematically as 156) allow the vacuum pressure in the two branches to be equalised. This arrangement reduces the problem of reduced suction that would be encountered near the side walls 106 if only a single vacuum line were connected to the vacuum chamber. As above, the valves are preferably ball valves, although again any suitable type of valve (e.g. butterfly valves) may be used.

In this embodiment, the cleaning fluid line 28 is linked via a connector 157 to a branched tube 158. Each branch of the tube is connected via respective valves (shown schematically as 32) and connectors 30 to one of three fishtail nozzles 26, 26′, 26″ arranged linearly along the width (the longer dimension) of the cleaning head. The valves in the branches allow the cleaning fluid pressure at the different nozzles to be equalised, or otherwise set as desired. Of course, larger numbers of nozzles may be used (as for example in the embodiment shown in Fig. 3).

As in the embodiment of Fig. 1, the valves 32 and connectors 30 are mounted on the outside of a long wall 102 of the vacuum chamber 101, while the fishtail nozzles 26, 26′, 26″ are inside the chamber. Part of this wall is cut away at 159 to show two of the fishtail nozzles 26, 26′. The position of the third fishtail nozzle 26″, obscured by the wall 102, is shown in dashed lines. This arrangement allows convenient adjustment of the valves, even while the cleaning system is in operation. Embodiments are also contemplated in which the valves are inside the vacuum mouth. These are less preferred, however, as they cannot be adjusted conveniently while the cleaning head is in operation.

Shown in Fig. 3, a still wider cleaning head has a three-way branched vacuum line 250. Again the three branches 252, 254, 255 are fitted with valves (shown schematically as 156). The cleaning fluid connector 157 is linked via a branched tube 258 to 5 fishtail nozzles 26a-e (of which 26a-c are visible in Fig. 3 behind the cut away portion 159 of the long wall 102; the positions of 26d and 26e, obscured by the wall 102, are shown in dashed lines). Again, valves (shown schematically as 32) in the branches allow the cleaning fluid pressure at the different nozzles to be equalised, or otherwise set as desired.